CHAPTER 2.—CONTINUOUS MINER AND ROOF BOLTER DUST CONTROL

By Fred N. Kissell, Ph.D.,[1] and Gerrit V. R. Goodman, Ph.D.[2]

In This Chapter

- ✓ Design and operation of machine-mounted scrubbers
- ✓ Dust control with scrubbers and blowing ventilation
- ✓ Dust control with scrubbers and exhaust ventilation
- ✓ Dust control with exhaust ventilation and no scrubber
- ✓ Dust control methods common to all continuous miner sections
- ✓ Dust control for roof bolters

This chapter explains how to control dust at continuous miner sections in coal mines where the main dust sources are continuous miners and roof bolters. In relation to dust, there are three categories of continuous miner faces depending on the type of ventilation and whether or not a machine-mounted dust scrubber is used. These are—

1. Mining machines with dust scrubbers used with blowing face ventilation
2. Mining machines with dust scrubbers used with exhaust face ventilation
3. Mining machines *without* scrubbers used with exhaust face ventilation

The approach to dust control is somewhat different in all three of these. However, there are many dust control features (such as the need to provide adequate airflow) common to all continuous miner sections.

For workers at roof bolter faces, there are two dust sources:

1. Dust from the continuous miner when it is upwind.
2. A malfunctioning dust collector on the bolter, which allows dust to escape

DESIGN AND OPERATION OF MACHINE-MOUNTED SCRUBBERS

> **Almost all new continuous miners are equipped with scrubbers. When the dust is excessive, it is possible that the scrubber needs some maintenance.**

[1]Research physical scientist.
[2]Mining engineer.
Pittsburgh Research Laboratory, National Institute for Occupational Safety and Health, Pittsburgh, PA.

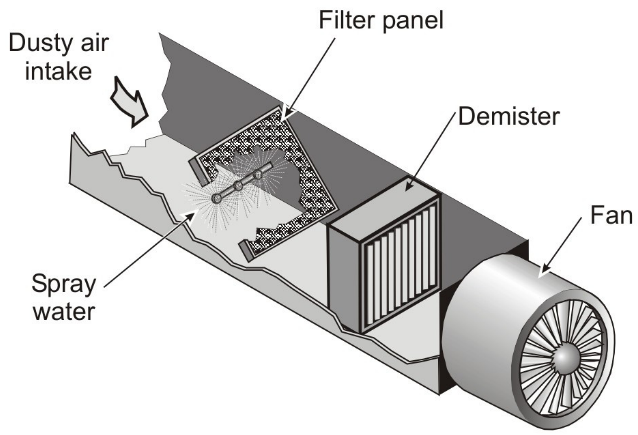

Figure 2-1.—Machine-mounted scrubber design.

Machine-mounted scrubbers, which are installed on continuous miners, collect dust-laden air through one or more inlets near the front of the miner and discharge cleaned air at the back of the miner. Figure 2-1 shows a typical design.

Inside the scrubber, the dust-laden air passes through a knit wire-mesh filter panel that is wetted with water sprays, which causes the dust particles to be captured by the water. After passing through the filter panel, the airstream then enters a demister, which removes the dust-laden water droplets from the airstream. The cleaned air passes through the fan and is then discharged at the back of the scrubber unit. Some scrubber designs have ductwork on the rear of the miner, which permits the discharge of air on either side of the machine.

Overall scrubber efficiency. The overall efficiency of the scrubber is determined by the fraction of face air that is drawn into the scrubber inlet (inlet capture efficiency) multiplied by the fraction of respirable dust removed from the captured air (filter efficiency). Overall efficiency ranges from 60% to 75% in most instances. However, several factors can cause the efficiency to decline. The most common is clogging of the filter panel.

Inlet capture efficiency. In practice, the inlet capture efficiency can be reduced by both working factors and machine design factors. The main working factors causing loss in inlet capture efficiency are entries that are large, spray pressures that are too high, and the use of blowing ventilation systems. Ideally, a dust scrubber should function like an exhaust ventilation system, drawing clean air forward over the miner and confining the dust cloud to that part of the miner that is forward of the inlet. When the entry is large, however, the scrubber capacity may not be adequate to maintain sufficient forward airflow over the miner.[3] The result is a rollback of dust, as depicted in figure 1-1. Excessive spray pressure or poorly aligned sprays also can cause rollback because of the turbulence and air movement they create. When air is delivered via blowing ventilation, and particularly with blowing duct, the amount of air delivered[4] to the face can exceed that removed by the scrubber. When this happens, dust-laden air is no longer confined to the front of the miner, but rolls back over the miner, contaminating the return air and the air breathed by workers. Specifics on how to deal with rollback are given later in this chapter.
The machine design factors that impact inlet capture efficiency are the scrubber air quantity and

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[3]When the entry size increases, the open area increases by a greater proportion because some of the entry is blocked by the miner.
[4]The amount of air delivered to the face includes both the airflow (the air jet) from the duct and that portion of the surrounding air induced into the jet.

the location of the inlets. The air quantity should always be as large as possible and the inlets as far forward and close to the cutting drum as practical [Jayaraman et al. 1992]. On high-coal machines, the inlets are usually distributed under the cutting boom, which is a good location because it is where the dust cloud is thickest. On low-coal machines, the inlet is usually at the boom hinge point, which is not as good because it is farther from the cutting drum. However, since low-coal machines usually work in entries where the clearance over the machine is less, the rollback of dust that might result from using a hinge point inlet may be offset by higher forward air velocities through a narrower space over the miner. Mines in high coal that use a hinge point inlet never reach adequate capture efficiencies, even with very high scrubber airflows [Hole and Von Glen 1998].[5]

One frequently asked question is what the airflow ratio should be, that is, the ratio of ventilation airflow to scrubber airflow. The most recent research [Fields et al. 1990] shows that this ratio is not particularly important for dust control, assuming there is enough ventilation airflow to dilute dust (and gas) and assuming that blowing systems are not used in a way[6] that overpowers the scrubber and causes a loss in inlet capture efficiency.

Filter efficiency. The thickness of the filter panel controls the filter efficiency. The original filter panel was made with 40 layers of stainless steel mesh knit from 85-micrometer stainless steel wire. Today, thinner filter panels containing 30, 20, and 10 layers of stainless steel mesh are available. The reduced filter thickness allows larger quantities of air to be moved by the scrubber, potentially improving inlet capture efficiency. However, thinner filters are less efficient at trapping dust. In a study by Colinet and Jankowski [2000], the 30-layer panel displayed a filter efficiency above 90% for respirable-sized dust, but the filter efficiency dropped too much when the thinner 20- and 10-layer panels were tested.

Scrubber maintenance. When the dust is excessive, it is likely that the scrubber needs maintenance. More than likely, some cleaning of the filter panel or ductwork is required.[7] The sprays should be checked to ensure they are completely wetting the entire filter panel, and not just the center. The density of the panel should also be checked to ensure that a panel of 30 layers was purchased.

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[5] Hole and Von Glen [1998] tested a scrubber for which the distance between the inlet and outlet was only about 8.2 ft. Air entrainment into the outlet jet produced a low-pressure region on the side of the machine that caused air at the front of the machine to bypass the inlet, further reducing the inlet capture efficiency.

[6] This is described in more detail in the next section.

[7] Schultz and Fields [1999] have noted that some scrubbers lose as much as one-third of their airflow after just one cut. Scrubber airflow can be monitored by measuring the filter differential pressure, the fan inlet pressure, or the fan motor current [Taylor et al. 1996].

Schultz and Fields [1999] reported a method used by one mine operator to block large pieces of coal from entering the scrubber inlets under the boom. The mine had installed a flap of conveyor belt about 8 inches inby each inlet and the flaps extended downward about 8 inches. The flaps forced the air to make an extra turn before entering the inlet, blocking the larger particles flying from the cutting drum. These flaps worked so well that the scrubber lost only 10% of its airflow capacity after an entire shift of operation.

DUST CONTROL WITH SCRUBBERS AND BLOWING VENTILATION

Dust scrubbers are most often used with blowing ventilation. When operator dust levels are too high, the most likely reason is that the operator is not spending enough time standing in front of the blowing line curtain.

With blowing face ventilation, fresh air is directed behind the line curtain or through ventilation duct and then discharged from the end of the line curtain/duct toward the face. This fresh air dilutes and entrains dust at the mining face, and the dust-laden air then passes out of the immediate face area and into the dust scrubber. After the dust is removed from the air, the air is discharged backwards from the rear of the mining machine on the side of the machine opposite the line curtain. A typical scrubber-blowing ventilation arrangement is shown in figure 2-2.

Remote placement of the mining machine operator. Although sections using blowing face ventilation use machine-mounted scrubbers, the operator can still be exposed to some of the respirable dust escaping the scrubber. This includes dust that escaped being drawn into the intake, as well as dust drawn into the intake but not collected by the filter panel. As a result, it can make a difference where the remote operator is located while operating the miner. A study by Jayaraman et al. [1987] in an Illinois mine measured the dust reduction benefits from positioning the operator in intake rather than return air, as shown in figure 2-2. The average intake level was 0.2 mg/m^3 and the average return level was 3.1 mg/m.^{3} This shows that a 94% reduction in operator exposure could be obtained by moving the operator to a position in front of the line curtain.[8] More recently, Goodman and

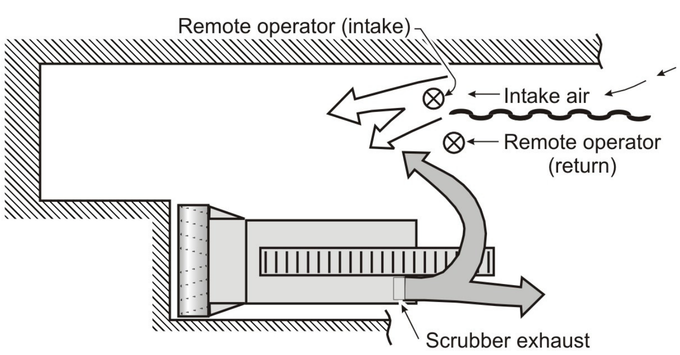

Figure 2-2.—Dust scrubber used with blowing ventilation.

[8]Gas emissions, MSHA guidelines regarding line curtain setback, and roof control plans may limit the selection of the best location from a dust exposure standpoint.

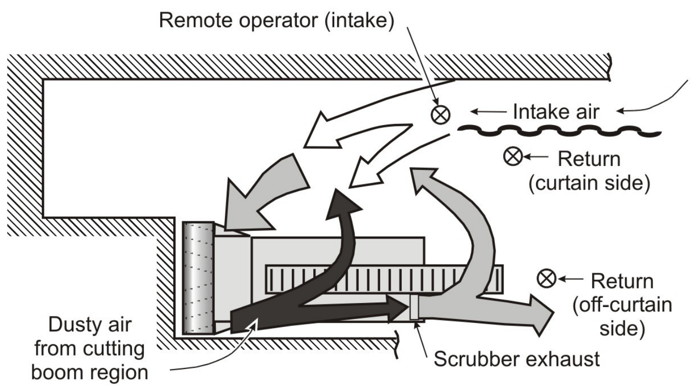

Figure 2-3.—Excessive air blown toward the face will cause dust to bypass the scrubber inlets.

Listak [1999] measured 0.79 mg/m^3 on a remote operator who spent most (but not all) of the time in front of the line curtain. The actual dust concentration of the intake air was 0.13 mg/m^3. Still, the dust reduction was 73% when compared to the return dust level of 2.9 mg/m^3.

Factors causing high dust levels. When remote operator dust levels are too high, the most likely reason is that the operator is not spending enough time standing in front of the blowing line curtain.[9] When downwind dust levels are too high,[10] it is likely that the scrubber needs maintenance. More than likely, some cleaning of the ductwork or filter panel is required. If the scrubber is operating properly, then the ventilation and the sprays should be checked. If the amount of air directed into the cutter boom region exceeds the amount of air withdrawn by the scrubber, then much of the dust cloud around the cutter boom will bypass the scrubber and move outby to contaminate the return (figure 2-3). This is the rollback of dust described earlier in this chapter. This excess air may be reduced by winging out the line curtain at the end to lower the velocity of the air emerging from behind it [Schultz and Fields 1999] or to pull the line curtain back slightly. Jayaraman et al. [1988] described successful experiments in a mine where the operator erected a short line curtain during the slab cut to shield the miner from the air jet emerging from a blowing duct.[11] However, the ability to use these techniques will depend on the amount of methane gas present, since limiting the fresh air may increase methane levels.

The dust cloud also can bypass the scrubber when the spray pressure is too high[12] or when directional sprays, such as in the "spray fan" system, are used. The resulting turbulence and air

[9]Some mines position the operator on the return side of the line curtain but very close to the line curtain. If the line curtain has a high leakage rate, this leakage air can reduce the operator's dust level. Occasionally, a mine will slit the line curtain and position the operator in the clean air emerging from the slit. How well this works is not known.

[10]The miner helper, the shuttle car operator, or other positions downwind.

[11]Dust problems caused by blowing too much air at the face are more prevalent when ventilation duct is used in place of blowing line curtain. This is because the jet of air from the duct is moving at a much higher velocity. Due to the higher velocity, the reach of the jet is extended and the amount of surrounding air entrained by the jet and pushed forward is much greater. The problem is common in Germany, where coal mine face ventilation systems use a blowing duct in combination with an exhaust system. The usual approach to reduce dust is to use a diffuser at the end of the blowing duct [Noack et al. 1989; Graumann and Gastberg 1984].

[12]Remedies include lowering the spray pressure to under 100 psi. The spray pressure is measured by removing a nozzle and attaching a hose that leads to a pressure gauge. See the section in this chapter on the antirollback spray system.

movement also will cause much of the dust cloud to bypass the scrubber inlet and move outby toward the operator.

DUST CONTROL WITH SCRUBBERS AND EXHAUST VENTILATION

As with blowing ventilation, the position of the operator is crucial for good dust control.

When exhaust ventilation is used with a scrubber, fresh air is drawn through the mine entry toward the face. This air then passes into the scrubber where it is cleaned of dust and discharged back toward the line curtain. From the line curtain, the air passes to the return. Figure 2-4 shows a typical scrubber-exhaust ventilation arrangement with the miner operated by remote control. As with blowing ventilation, the location where the mining machine operator stands greatly changes his or her dust level. However, dust levels in exhaust ventilation sections can be lower than those in blowing ventilation sections because the mining machine operator has more options as to where to stand and stay out of the dust cloud. Also, the shuttle car operator is working in fresh air.

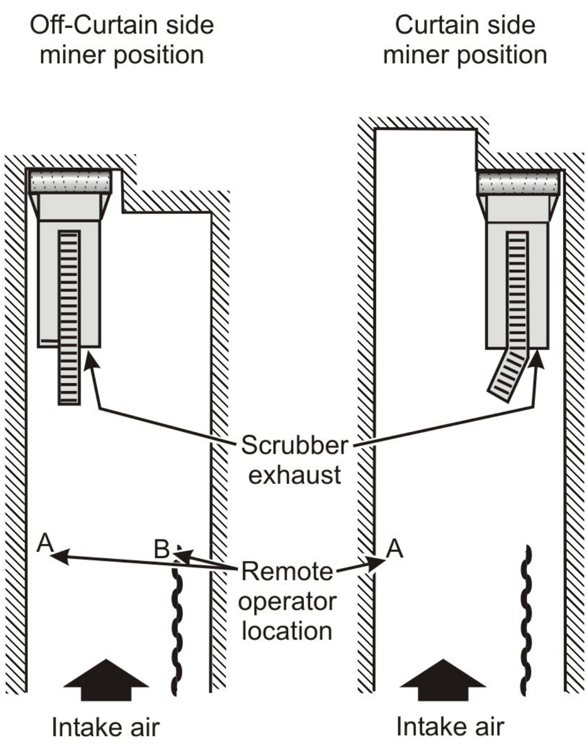

Figure 2-4.—Dust scrubber used with exhaust ventilation.

In a mine using a machine-mounted scrubber and exhaust ventilation, Goodman and Listak [1999] measured dust levels at the mining machine and at the remote operator location. The entry size was 10 ft by 20 ft. The scrubber flow was 9,500 cfm, and the air quantity exhausted by the line curtain was 15,000 cfm. For the box cut (figure 2-4, left), the remote operator stood at locations A or B; for the slab cut (figure 2-4, right), at location A only. Both locations were parallel with the end of the line curtain. The dust level at the right rear corner of the miner (the cab location on nonremote machines) was 4.3 mg/m^3; the dust level for the remote operator location was 0.79 mg/m^3, about 80% lower than the cab location.

Goodman and Listak also found that when the remote operator positioned himself at location A, he could move a few feet inby toward the face without his dust level increasing much. However, when he stood at location B and moved a few feet inby, his dust level rose significantly because he had moved out of the intake air zone.

In another study of scrubbers and exhaust ventilation, Colinet and Jankowski [1996] used a full-scale lab model to assess the dust impact of moving the location of the remote operator while changing the distance from the end of the line curtain to the face, the line curtain airflow, and the water pressure. The entry size was 9 ft by 18 ft, and the scrubber flow was 7,800 cfm. Tests were done with the airflow ranging from 3,000 to 13,000 cfm, the line curtain-to-face distance from 30 to 40 ft, and the water spray pressure from 60 to 200 psi. Dust was measured at location A shown in figure 2-4, 5 ft inby location A, and 5 ft outby location A. Colinet and Jankowski found higher dust levels at the inby location and recommended that operators always position themselves either at location A, parallel to the end of the line curtain, or outby. At these recommended locations, changing the water pressure and line curtain-to-face distance had no effect on dust levels. Changing the airflow from 3,000 to 13,000 cfm produced a modest[13] 0.5 mg/m^3 decrease in dust. Colinet and Jankowski also point out that the scrubber exhaust must be on the same side of the entry as the line curtain and that this may require a crossover air duct at the rear of the miner.

When the dust level is too high, the first thing to check is whether the operator is standing parallel to or outby the end of the line curtain. Other factors to check are whether the jet from the scrubber exhaust is on the same side of the entry of the line curtain, whether the line curtain end is outby the scrubber exhaust, and whether the air in the jet is all passing behind the line curtain rather than backing up against the intake air. To test if the air in the jet is all passing directly behind the line curtain, the contents of a dry powder fire extinguisher should be released into the scrubber exhaust stream. Then, observe whether all of the powder goes behind the line curtain.

DUST CONTROL WITH EXHAUST VENTILATION AND NO SCRUBBER

Exhaust ventilation alone can be a very effective way to control dust. The quantity of ventilation air is the most important factor in controlling dust exposure.

With exhaust ventilation, fresh air is drawn up the mine entry to the face to dilute and entrain dust. Dust-laden air is then pulled from the face area and carried behind the line curtain or into ventilation duct and out of the face area.

Over 15 years ago, the U.S. Bureau of Mines (USBM) surveyed 12 continuous miner sections that were at or below 0.5 mg/m^3 during the previous 18 months [USBM 1985b]. Three features were common in all or most of the sections: good ventilation, good spray systems, and a modi-

[13]This amount is modest considering such a huge change in the airflow.

fied cutting cycle. The last two of these are discussed later in this chapter. The first, good ventilation, is discussed here.

Good ventilation. At all mines surveyed, the quantity of face ventilation air was the most important factor in controlling dust exposure.[14] The mean entry air velocity ranged from 63 to 335 ft/min and averaged 122 ft/min. In all cases, the distance from the face to the end of the line curtain/duct was 15 ft or less. Eight of the mines used exhaust duct with an auxiliary fan. At the other mines, the exhaust line curtain was very well maintained, and leakage was minimized by sealing the floor/line curtain interface. The high entry air velocity, averaging 122 ft/min, reduced dust rollback significantly. Rollback takes place when turbulence from the water sprays causes the dust cloud to spread toward the miner operator. Because of the high air velocity, dust generated by coal extraction was usually confined to the face area, and any operator exposure was usually from intake sources such as shuttle car loading and haulage.

Unfortunately, achieving a high ventilation air velocity is not always possible. Mine operators who cannot supply a high air velocity have three alternatives: a half-curtain, antirollback sprays, and remote control. The last two of these are discussed in the section on common dust control methods. The first, a half-curtain, is discussed here.

Half-curtain. Mines in high coal may have difficulty achieving adequate air velocities because the cross-sectional area of the mine entry is larger than normal. Although the quantity of air delivered may be large, inadequate air velocities will permit the dust cloud at the face to roll back over the miner operator. The half-curtain [Jayaraman et al. 1986] is a piece of brattice cloth supported by two pogo sticks. It is placed perpendicular to the rib just inby the operator's position and extends from roof to floor (figure 2-5).[15] The half-curtain reduces the cross-sectional area of the entry, thus increasing the air velocity in the region between the operator and the dust source. Results of a lab study show that the half-curtain performance depends largely on placement. The greatest improvement (86%) was achieved when the half-curtain was outby the end of the line curtain and just inby the operator. Underground tests show that with the half-curtain, the respirable dust exposure of the operator was reduced by 50%.

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[14]A full-scale lab study by Colinet et al. [1991] reached the same conclusion.

[15]The half-curtain shown in figure 2-5 is on the off-curtain (duct) side of the entry. It also can be placed on the curtain (duct) side of the entry. Some mines using exhaust duct have placed a narrow curtain at the end of the duct to enlarge the capture area of the duct. This might be described as a quarter-curtain rather than a half-curtain, since the area blocked is much less. Nevertheless, it can reduce dust for the same reason, particularly if the air velocity is in the critical 40-60 ft/min range, where minor differences in air velocity can make large differences in the dust level.

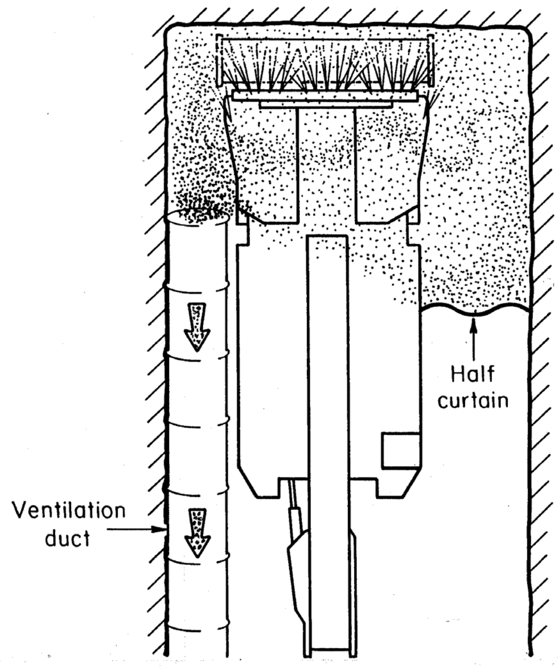

Figure 2-5.—Half-curtain location.

In gassy mines, caution must be used to ensure that hazardous accumulations of methane do not build up behind the half-curtain during the box cut. Jayaraman et al. [1986] also give procedures to follow when gas is present.

When dust levels are too high, the air velocity and the distance from the face to the end of the line curtain or duct should be checked. These are both critical.[16] Studies have shown that dust levels are much lower when the end of the line curtain or duct[17] is located close to the face. For this reason, the end of the exhaust line curtain or duct should be maintained within 10 ft of the face. Also, when using exhaust ventilation, mean entry air velocities above 60 ft/min have been shown to minimize dust. Both the 10-ft and 60-ft/min criteria are required by Mine Safety and Health Administration (MSHA) regulations.

If these ventilation changes are not possible or if dust levels are still too high, the methods described in the next section should be considered.

DUST CONTROL METHODS COMMON TO ALL CONTINUOUS MINER SECTIONS

Many dust control methods are common to all continuous miner sections. These include good spray systems, a modified cutting cycle, remote control, good water filtration, and regular bit replacement.

The first two dust control methods in this section, good spray systems and a modified cutting cycle, originated in the USBM survey [USBM 1985b] of continuous miner sections with dust levels of 0.5 mg/m^3 or less, as discussed in the last section.

Good spray systems. All spray systems in the USBM survey were well maintained and completely functional. Water flow to the miners in the survey averaged 29 gpm. Also, sprays

[16]See figure 6-5.

[17]When ventilation duct is used, a convenient way to keep the end close to the face is to incorporate a smaller diameter sliding section into the last fixed segment.

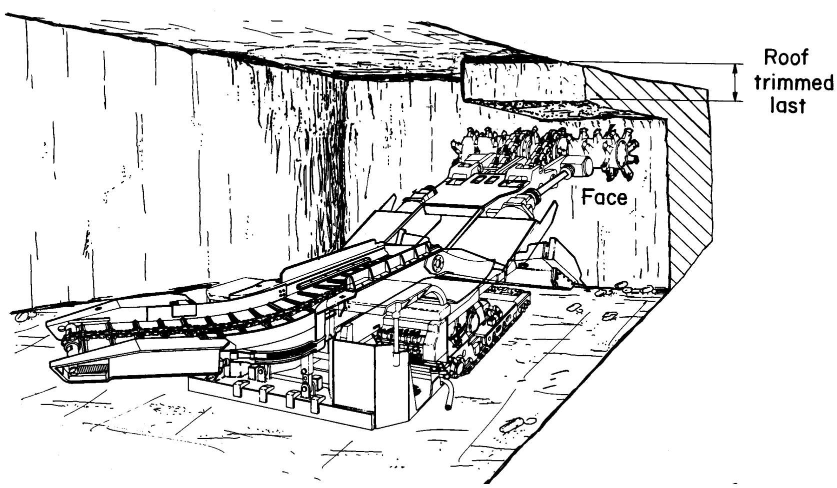

Figure 2-6.—Modified cutting cycle. In this cutting cycle, the roof is trimmed last.

were mounted on the flight conveyor with a total flow averaging 5 gpm. These flight conveyor sprays served to add water to the cut material before discharge onto the shuttle car, thereby reducing the operator's exposure to this intake dust source.

Field studies by Matta [1976] and by Courtney et al. [1978] have shown that sprays under the boom are somewhat more effective than sprays on top.

Modified cutting cycle. The USBM survey of low-dust continuous miner sections also found that two-thirds of the surveyed mines used a modified cutting cycle (figure 2-6). The usual cutting cycle is to sump in at the roof and then shear down to the floor. With the modified cutting cycle, the machine sumps into the coal face a foot below the roof and then shears down to the floor. This is continued for at least two sump/shear sequences. The miner then backs up and trims the remaining rock and coal from the roof.

This modified cutting cycle leaves the roof rock in place until it can be cut out to a free face, generating less dust (and particularly less quartz dust).[18] Also, some operators have found that the modified cutting cycle provides better machine control. They reported that it prevents the machine from climbing into the roof when sumping high.

Remote control. If machine operators can avoid dusty areas and remain in uncontaminated air, their dust exposure will be much lower.[19] Remote control of the miner is the way to accomplish this. With exhaust ventilation, dust is avoided by moving away from the face and back into intake air. With blowing ventilation that uses a line curtain, dust is avoided by stepping in front of the line curtain. In either case, dust reductions of 90% are possible. Remote control allows the operator to step back and get away from the dust cloud that surrounds the machine. Several studies have shown how effective remote control can be [Divers et al. 1982; Jayaraman et al. 1987; Goodman and Listak 1999].

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[18]Jayaraman et al. [1988] describe experiments at a mine where the operator used a modified cutting procedure to deal with a high level of quartz dust that originated from cutting a sandstone floor. The miner sumped into the coal face about 6 inches above the floor and sheared upwards. The bench on the floor was then trimmed separately. This change, combined with a curtain to confine the dust cloud during removal of the slab, cut the dust concentration in half and also cut the quartz percentage in half.

[19]A downside of remote control is that it may remove the operator from a location that is protected from roof falls, such as the cab of a continuous miner.

Remote control is one of the best, if not *the* best, dust control available for all kinds of mining machinery.

Antirollback water spray system. A way to counter rollback resulting from low air velocity is to use an antirollback spray system (figure 2-7) [Jayaraman et al. 1984]. Most conventional spray systems consist of multiple nozzles (15 to 30) located across the top and along the side of the miner boom. Jayaraman et al. [1984] showed that many water spray systems produce enough air turbulence to overwhelm the primary airflow, causing dust rollback. Spray system characteristics that promote rollback are:

(1) High spray pressure (over 100 psi), which increases air turbulence at the face more than it suppresses dust. Tests have shown that a moderate spray pressure of 100 psi, measured at the nozzle, is a practical maximum pressure. However, water flows should be as high as possible. The spray pressure is measured by removing a nozzle and attaching a hose that leads to a pressure gauge.

(2) Top and side sprays with wide-angle cones that purposely overspray the cutter head or are set on the boom too far back from the cutter head. The longer the spray path, the more air is set in motion, and this air movement stirs up dust. A typical miner spray does most of its airborne dust collection in the first 12 inches; thus, top and side nozzles should be arranged for "low" reach and no overspray (figure 2-7, *A* and *B*). Flat fan sprays delivering about 1 gpm per nozzle are best suited for this application since the entire flow from the nozzle can be directed onto the cutter head. Underneath the boom, deluge-type nozzles delivering about 5 gpm per nozzle should be used to wet the broken coal. These nozzles should be mounted in a protected location close to the edge of the boom to ease servicing.

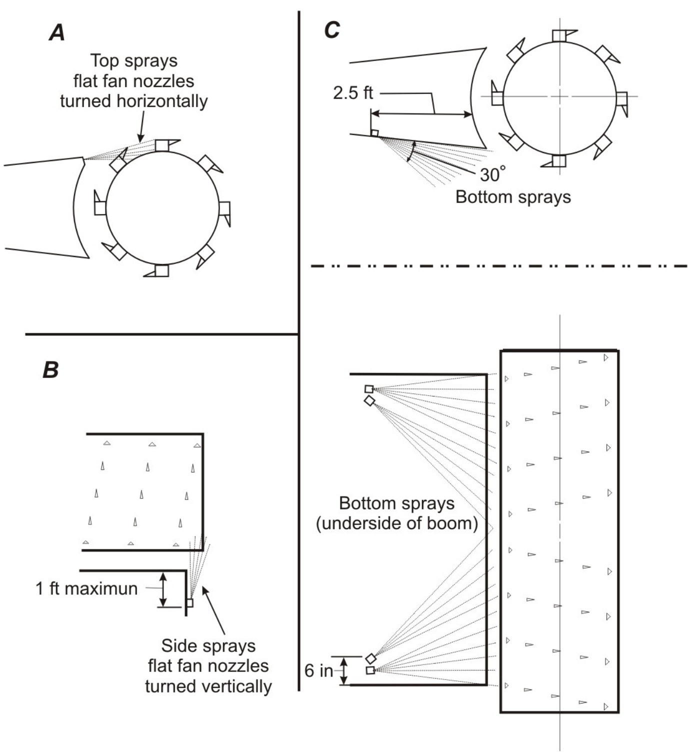

Figure 2-7.—Antirollback water spray system.

In underground trials, the antirollback spray system reduced dust levels at the operator's position by 40%[20] compared to conventional sprays.

Good water filtration. Dirt and rust particles in the water line cause frequent clogging of spray nozzles. A simple, nonclogging water filtration system is available to replace conventional spray filters [Divers 1976]. The system

[20]Without using the underboom sprays.

consists of an in-line Y-strainer to remove the plus 1/8-in material, a hydrocyclone to remove most of the remaining particles, and a polishing filter to remove the few particles that are not trapped by the hydrocyclone during startup and shutdown of the spray system. A new type of removable manifold that facilitates the quick changing of clogged sprays can also be used. To construct it, obtain a piece of 0.5-in wall pipe that is 0.5- to 2-ft long, depending on the intended location. Cut a lengthwise slot in the pipe. Weld the pipe to the miner with the slot facing forward. Fabricate a conventional spray bar from a second piece of pipe that slides into the slotted heavy wall pipe with the nozzles keyed into the slot and aimed out of the slot. Devise some means to hold the smaller pipe in place so that it can be removed to service the nozzles.

Regular bit replacement. Routine inspection of the cutting drum and replacement of dull, broken, or missing bits improves cutting efficiency and helps to minimize dust. Also, Organiscak et al. [1996] showed that bits designed with large carbide inserts and smooth transitions between the carbide and steel shank typically produce less dust.

Reduction of intake dust. Intake dust is often overlooked as a source of dust overexposure. Intake sources may include movement of outby equipment on dry roadways, feeder-breakers, and conveyor belts. Methods to reduce conveyor belt dust are described in chapter 6 on hard-rock mines. Methods to reduce haul road dust are described in chapter 5 on surface mines. Potts and Jankowski [1992] measured the dust level impact of using belt air for face ventilation, both on continuous miner and longwall sections.

Bolter dust collector maintenance. Occasionally, a malfunctioning bolter dust collector upwind of the miner will produce enough quartz dust to raise the exposure of the continuous miner operator. This is more likely to create a compliance problem on sections that are on reduced (more stringent) standards because of quartz in the coal. In such instances, additional quartz from the bolter, even in small amounts, will have significant impact. As much as 25% of the continuous miner operator's quartz dust exposure can be attributed to dust from the bolting operation. The problem is usually a lack of maintenance on the bolter dust collector.

DUST CONTROL FOR ROOF BOLTERS

Dust at bolter faces originates from the continuous miner if it is upwind or from a malfunctioning dust collector at the bolter itself. In most instances, high dust exposures are easily remedied.

Dust from upwind sources. If the bolter dust collection systems are operating properly, most of the bolter operator's dust exposure is generated by the continuous miner when it is upwind. The best way to reduce this bolter exposure is to use double-split ventilation. If single-split ventilation is being used, then the cutting sequence must be designed to limit the amount of time that the continuous miner is upwind.

If the continuous miner has a scrubber and the bolter dust exposure is still high, the scrubber should be checked to ensure that it is operating properly. Other techniques for reducing the dust level of personnel downwind of a continuous miner have been described by Jayaraman et al. [1989].

Dust from the bolter. While most of the roof bolter operator's dust exposure comes from upwind sources (e.g., the continuous miner), some bolting machines allow a significant amount of dust to escape the dust collector system, thus contaminating the region around the bolter. Such contamination is more likely when an insufficient amount of clean air is available to dilute the dust.

When dry dust collection systems are leaking, dust emission from the blower exhaust is the most common problem. It is usually caused by damaged or improperly seated filters. Also, many roof bolter dust collectors show accumulations of dust between the filters and blower, which results from past or current filter leaks. With the filters removed and the access door open, this dust can be removed by back-flushing the system with compressed air or by running the blower for several minutes.

Proper disposal of the dust that accumulates in the dust collector box can be important, since this dust is easily stirred up by mine traffic if just dumped onto the middle of the mine floor. Goodman and Organiscak [2002] compared two methods of cleaning the dust collector box. One was the common practice of using a metal rake to scrape the cuttings out of the collection box onto the mine floor. A second method was to collect the dust in a bag contained within the largest compartment of the dust box. When full of dust, the bag is carried to the rib and gently dumped. Comparisons of the bag versus the metal rake for cleaning the dust box showed that respirable coal dust and respirable silica dust exposures for the bolter operators dropped by a factor of two when the bag was used. Disposable bags are now available for some bolters.

Dust from the drill hole can also pose a problem. A visible plume from the collar of the drill hole is a sign of inadequate airflow to the chuck or bit. The air leaks that cause inadequate airflow occur mainly at loose hose connections, through the pressure relief valve, and through poorly fitting dust collector access doors. It is common to find as much as 50% leakage.

The bit type also makes a difference in the dust escaping from the drill hole. In one study, shank-type bits allowed from 3 to 10 times more dust to escape from the drill hole collar than "dust hog" bits [USBM 1985a]. Most of this dust escaped during the first few inches of bit penetration. Typically, the dust hog bits generate one-fifth of the dust generated by the shank bits in the initial 12 inches and one-third of the dust over the full length of the hole.

Some years ago, MSHA did a survey to evaluate the effectiveness of improved maintenance on dry dust collection systems [Thaxton 1984]. During the survey, the mine operators replaced all duct hoses, filters, and the blower muffler, repaired the vacuum system and dust box seals, and cleaned the blower unit. Results showed major improvements in both the quartz percentages and the dust levels.

A small proportion of roof bolters use wet systems to control dust. In wet systems, hollow drill steels are used to deliver low-pressure water (2 gpm per chuck) to the bits. These systems offer improved bit life, faster drilling, and excellent dust control. However, wet drilling can create problems in coal mines that cannot tolerate additional water on the mine floor. Also, leaking water seals can splash water over the bolter operators, making for unpleasant working conditions. As a result, good maintenance of all seals is important.

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